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Course Details

Instructor and office hours

Instructor: David R. Caprette, Ph.D.
Professor in the practice, Biochemistry & Cell Biology
Office and contact information: ABL 327, caprette@rice.edu, x3498
Hours by appointment

Brief description and expectations

NOTE: This course begins with a significant amount of pre-class preparation. Please see the detailed schedule for spring 2015 following the meeting schedule, below.

In BIOC 415 (Experimental Physiology), teams of students explore the properties of excitable cells and the mechanisms behind those properties. Experimental studies focus on the origin of membrane potentials, generation/propagation of action potentials and properties of nerves, and mechanisms for controlling muscle contractile strength. BIOC 415 is a "capstone" laboratory course, meaning that students are expected to apply previously learned skills to new studies. As a student in BIOC 415 you are expected to:

- Read the detailed schedule well ahead of each class and prepare for class as instructed
- Read and understand background material and be prepared to discuss the concepts in class
- Study the resources provided by the instructor and be prepared to apply what you have learned to discussions and laboratory work
- Actively participate in class discussions and at times lead the discussion
- Take a goal-oriented approach to the laboratory work by developing hypotheses and experimental protocols with which to test them
- Collect, record, share, and analyze data using the best practices that you have acquired in previous lab courses and/or independent study
- Employ text and figures in order to present your findings in publishable form
- Write up interpretations of the findings (discussions) that explain them in terms of physical/molecular mechanisms
- Adhere to the spirit, not just the letter, of the honor code

Course grade

Assignments will contribute to the final course grade in the following proportions. See the detailed meeting schedule for assignments and due dates.

- unannounced quizzes, participation in discussions, experimental protocols, and laboratory work, 40%
- two research papers (results and discussion only), 30% each

Policies

On time attendance is required, and makeup labs are not possible. Some class meetings will begin with an unannounced quiz with a time limit. Missed quizzes cannot be made up. The class and instructor will decide on the due date for each research paper. Once the due date is set the usual late policy applies. The grade for any late assignment will be reduced by 10% for each day or part of day past the original due date and time. For example, if the paper is due at 1 pm in class and is received that evening, the grade will be reduced by 10%. If it is received after 1 pm the following day the deduction will be 20%. Saturdays, Sundays, and holidays count. Electronic submissions are accepted.

Honor code policy

The Rice honor code applies to all assignments in this course. Students will work together to plan and conduct experiments and to compile raw data. In class we will discuss how to analyze the data and interpret the findings, and you are free to continue such discussions outside of class. You may want to share ideas on how to convert raw data to a presentable form, statistics or visual elements (e.g., graphs) to employ, what the findings mean, mechanisms that explain the findings, etc. Collaboration is to be limited to discussions only. **Aside from sharing your ideas, the final work must be your own work, in entirety. There is to be no co-writing of experimental designs or papers, paraphrasing of other students' work, or sharing of figures or tables.** Students are not to allow access by other students to any of their work whether it is in preparation or in final form.

Students with disabilities

Any student with a documented disability needing adjustments or accommodations is requested to speak with Dr. Caprette during the first two weeks of class. All discussions will remain confidential. Such students should also contact Disability Support Services in the Ley Student Center.

Meeting schedule

Please see the Detailed Schedule (next section below) for a list of pre-lab and post-lab assignments and due dates. Note that there will be a quiz on the first day. Remaining quizzes will be unannounced. On Jan 28 we will begin class at 2 pm rather than 1 pm.

Day/date/time/place	Topic
Monday Jan 12, 1 PM, ABL 329, GBH W112	Course introduction, quiz, student-led discussions of background material, software tutorial
Weds Jan 14, 1 PM, ABL 329, GBH W112	First membrane potential lab
Monday Jan 19 MLK HOLIDAY	
Weds Jan 21, 1 PM, ABL 329, GBH W112	Second membrane potential lab
Monday Jan 26, 1 PM, ABL 329	Followup on membrane labs
Wednesday Jan 28 2 PM, ABL 329, GBH W112	Introduction to nerve recording and software tutorial (Scope)
Monday Feb 2, 1 PM, ABL 329, GBH W112	Nerve lab 1
Wednesday Feb 4, 1 PM, ABL 329, GBH W112	Nerve lab 2
Monday Feb 9, 1 PM, ABL 329	Follow up nerve labs
Wednesday Feb 11, 1 PM, ABL 329	Introduction to nerve/muscle studies
Monday Feb 16, 1 PM, GBH W112	Muscle lab 1
Wednesday Feb 18, 1 PM, GBH W112	Muscle lab 2
Monday Feb 23, 1 PM, ABL 329	Follow up muscle labs

Detailed schedule for spring 2015

In the Resources section you will find a laboratory manual, a set of Appendixes, materials on basic electricity, PowerPoint notes pages on selected topics, and a list of questions to be addressed in class. I will also post class data sets as you generate the data in lab. All data are the property of the entire class and should be used, selectively, for your final papers. All assignments other than the research papers are to be printed (not handwritten) and submitted as hard copies at the beginning of class. The research papers should be dropped off with the instructor, placed in the instructor's IN box or department mailbox, or prepared as a pdf and sent to the instructor as an email attachment.

Day/time/place/topics	Activities
Mon Jan 12, 1 PM, ABL 329, GBH W112 Course introduction, prepare for studies on the origin of the membrane potential	*Preparation (in advance of the first class meeting)* • Review Appendixes A, B, C (folder Manual, in Resources) • Review the principles of basic electricity including DC electricity, Ohm's law, and capacitance (folder Electricity) • Be prepared to apply Ohm's law • Read chapter 1 of the manual up to diffusion potentials (page 11) • Peruse the resources "equilibrium_potential.pdf," "sodium pump.pdf," and "microelectrodes.pdf" in the Tutorials folder • Peruse the questions for today (questions.pdf) and be prepared to lead a discussion *Introduction and quiz* • Introductions - names, majors, why you are taking the course • Decide on team assignments • Quiz on preparation for day 1 • Review quiz answers *Student-led discussion* • Course introduction including lab studies, assignments, grading • Discuss equilibrium potentials (equilibrium_potential.pdf) • Discuss the electrogenic property of the sodium pump (sodium_pump.pdf) • Discuss the use of microelectrodes for measuring membrane potentials • Plan the laboratory work to study the electrogenic contribution of the sodium pump in crayfish extensor muscle *Guided discussions* • A/D recording, data to be recorded, transducers, calibrating and using an IC probe • Preparing an experimental protocol *Laboratory (GBH W112)* • Self-paced tutorial on using data acquisition software • Learn to calibrate an IC probe and measure electrode tip resistance
Weds Jan14, 1 PM, ABL 329, GBH W112 First membrane potential lab	*Preparation* • Estimate resting potential using Nernst equation with the potassium concentrations provided • Review the appendix material on preparing an experimental protocol • Plan today's experiment and bring your plan to the discussion • Prepare to answer the questions posed for today (questions.pdf) *Student-led discussion* • Briefly discuss the questions posed for today *Laboratory*

	• Demonstration on crayfish dissection, measuring a membrane potential • Precautions when using microelectrodes and holders • Troubleshooting suggestions • Measure control E_m values and short term effect of ouabain on E_m *Followup* • Email today's results (raw data) by the end of the day • Prior to the next class, use the class data posted by the instructor to prepare a preliminary analysis of the ouabain experiment; expect to discuss the findings
Mon Jan 19	**MLK HOLIDAY**
Weds Jan 21, 1 PM, ABL 329, GBH W112 Second membrane potential lab	*Preparation* • Have the results of your data analysis ready for class (not to be turned in) • Read remainder of chapter 1 • Peruse the resources "ion_movements.pdf," "diffusion_potential.pdf," and "concentrations.pdf" • Use the GHK equation to predict E_m in the variable K^+ and Na^+ solutions that we will be using, and compare with predictions using the Nernst equation for K^+ • Be prepared to answer the questions posed for today • Review the recommendations for collecting membrane potential data, including how to avoid complications due to bad microelectrodes, electronic noise, hysteresis, etc. (p. 5-7 of the manual) • Prepare a plan for the experiments involving variable K^+ and Na^+ solutions, including hypothesis(es) to be tested; plan should incorporate data collection by all four teams. Have a printed copy of your plan ready to turn in *Student-led discussions* • Address today's questions • Plan for the second membrane experiment, including experimental controls *Laboratory* • Dissect crayfish, measure E_m in variable K^+ and Na^+ solutions *Followup* • Compile your data and send to the instructor by the end of the day • Conduct a preliminary analysis of the class data (posted by the instructor) before the next class
Mon Jan 26, 1 PM, ABL 329 Discuss findings from the membrane labs and their	*Preparation* • Prepare to discuss the questions for today *Student-led discussion*

interpretation	• Share ideas for analyzing, presenting, and interpreting the data from the ouabain experiment • Discuss the questions posed for today • Share ideas for analyzing, presenting, interpreting the data from the variable K^+ and Na^+ solutions Today we will decide on a due date for the first research paper
Wednesday Jan 28, 2 PM, ABL 329, GBH W112 Introduction to the nerve studies; learning to use the Scope software	Note the change in start time *Preparation* • Read chapter 2 with emphasis on the material up to page 23, conduction velocities (skim the dissection details) • Be prepared to discuss the questions posed for today *Student-led discussions* • Initiation and propagation of action potentials • Differences between a compound action potential and a single action potential • Introduce the recruitment study; what will you be doing and why? • Introduce the strength-duration experiment and its rationale *Guided discussion* • Why was it necessary to abandon the equilibrium potential model? • Recording a compound action potential *Laboratory* • Self paced tutorial - learn to use Scope software
Monday Feb 2, 1 PM, ABL 329, GBH W112 Nerve lab 1	*Preparation* • Prepare a protocol for the recruitment and strength-duration studies, including a complete plan for data collection and plans for analyzing and presenting the data; **to be submitted in class** • Be prepared to describe the temporal and spatial relationships among stimulus and recording electrodes and phases of a CAP • Be prepared to estimate duration and magnitude of a typical CAP *Laboratory* • Instructor demonstration: dissection, chamber preparation, recording a CAP • Prepare nerve, collect recruitment and S-D data • Time permitting, explore nerve properties, including velocity, refractory period, start planning data collection for next time *Followup* • Send raw data to the instructor within 24 hours • Prepare a preliminary analysis of the recruitment and strength-duration data prior to the next class

Wednesday Feb 4, 1 PM, ABL 329, GBH W112 Nerve lab 2	*Preparation* • Review chapter 2 of the manual with emphasis on pages 23 to the end of the chapter • Prepare a protocol for studying conduction velocity and refractory periods (not to be turned in) *Student-led discussions* • Share your plans for analyzing the recruitment and strength-duration data • Discuss the function of a myelin sheath, saltatory conduction, and why some axons conduct faster than others • Discuss the rationale behind absolute and relative refractory periods • Share plans for the studies on conduction velocity and estimating a refractory period *Laboratory* • Estimate conduction velocities using alternative methods • Conduct two series of refractory period experiments, one with threshold stimulus, one with suprathreshold stimulus • Explore changes in properties of the compound action potential with the nerve partly blocked with lildocaine *Followup* • Send raw data to the instructor within 24 hours • Prepare a preliminary analysis of all of the nerve study data
Monday Feb 9, 1 PM, ABL 329 Follow up the nerve labs	*Preparation* • Do your best to explain each of the findings, including patterns you saw during the recruitment study, results from the strength-duration experiment, studies on the refractory period, conduction velocity, and nerve block • Be prepared to answer the questions posed for today. *Student-led discussio*n • Share your findings, explanations, mechanisms, and significance, one experiment at a time • Share your ideas for the best ways of presenting the findings in text and as figures
Wednesday Feb 11, 1 PM, ABL 329 Introduction to the nerve-muscle studies	*Preparation* • Read chapter 3 with emphasis on material up to and including regulation of contractile strength by stimulus frequency • Review excitation contraction coupling in muscle with emphasis on the role of calcium • Be prepared to answer the questions posed for today *Student-led discussion*

	• Discuss motor units and the relationship between tension and compound action potential • Review excitation/contraction coupling in muscle • Discuss the role of calcium in mediating frequency dependent changes in contraction strength • Plan the studies on recruitment and effects of frequency *Laboratory* • Calibrate force transducers and set up Units Conversion (volts to grams) for the nerve/muscle lab
Monday Feb 16, 1 PM, GBH W112 Muscle lab 1	*Preparation* • Prepare a protocol to study treppe, incomplete, complete tetanus, recruitment of motor units (not to be turned in) *Laboratory* • Instructor demonstration: nerve/muscle preparation; recording data in "windows" • Prepare nerve & muscle for recording data • Collect data for Treppe, recruitment of motor units, frequency-dependent contractile force (tetanus) *Followup* • Send raw data to the instructor within 24 hours
Wednesday Feb 18, 1 PM, GBH W112 Muscle lab 2	*Preparation* • Review chapter 3 with emphasis on length-tension relationships • Prepare a plan for collecting length-tension data *Laboratory* • Prepare nerve/muscle for recording data • Collect data on isotonic, isometric length-tension relationships and design experiment on fatigue *Followup* • Send raw data to the instructor within 24 hours • Prepare a preliminary analysis of all of the nerve-muscle data
Monday Feb 23, ABL 329 Follow up muscle labs	*Preparation* • Be prepared to share ideas for interpreting the data *Student-led discussion* • Discuss ideas for analyzing and interpreting the recruitment and frequency data • Discuss how to analyze and interpret the length-tension data • Summarize the conclusions from the fatigue experiments

	• [with instructor] Set the due date for the second and last paper, which can be the nerve studies or the nerve-muscle studies – each individual chooses